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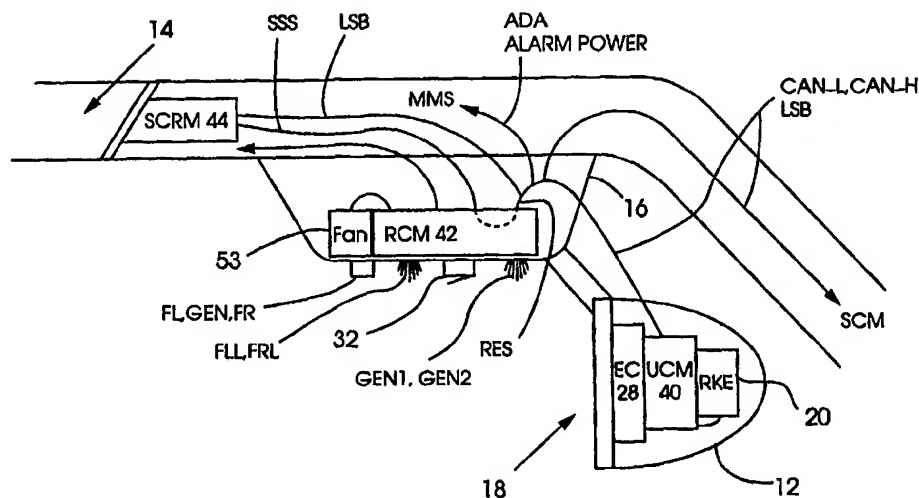
(57) Abstract

A vehicle control system comprises an industry standard CAN network with a number of nodes distributed around the vehicle for controlling corresponding parts of the vehicle. One such node (40) is located in the housing (12) of the vehicle interior rearview mirror (18) and directly controls the reflectivity of an electro–optic mirror unit (28), in accordance with the state of at least one ambient light sensor, and a remote keyless entry device (20). The node (40) also communicates via an ISO9141 interface with a number of slave controllers such as a sun–roof control module (44) mounted adjacent a sun–roof (14) and a roof control module (42) mounted in a roof housing (16). By this means the UCM (40) exercises indirect control of the sun–roof (14) in accordance with the state of a switch (32), and exercises indirect control of various lamps GEN1, GEN2, FLL and FRL in the roof housing (16) in accordance with the state of switches Gen, FL and FR mounted in the roof housing (16) or, in the case of the lamps GEN1 and GEN2, when a vehicle door is opened.

A VEHICLE REARVIEW MIRROR AND A VEHICLE
CONTROL SYSTEM INCORPORATING SUCH MIRROR

The present invention relates to a vehicle rearview
mirror and a vehicle control system incorporating such
mirror.

According to the present invention there is provided a
vehicle rearview mirror comprising a mirror housing
containing a variable reflectivity mirror unit and a
microcontroller for controlling the reflectivity of the
mirror unit.

There is also provided, as a further independent
invention, a vehicle control system comprising a
rearview mirror housing, a variable reflectivity mirror
unit mounted in the mirror housing, a master
microcontroller mounted in the mirror housing for
controlling the reflectivity of the mirror unit, a roof
housing positioned on the interior roof of the vehicle,
a slave microcontroller mounted in the roof housing and
connected to the master microcontroller, and at least
one input and/or output device connected to the slave
microcontroller.

There is also provided, as a further independent
invention, a vehicle control system comprising a network
controlling a plurality of functions of the vehicle, the
network having a node located in a rearview mirror
housing of the vehicle, such node controlling at least
one function of the mirror.

There is also provided, as a further independent
invention, apparatus for controlling an optical
characteristic of a vehicle component in accordance with
the duty cycle of a pulse width modulated signal.

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An embodiment of the invention will now be described, by
way of example, with reference to the accompanying
drawings, in which:

5   Figure 1 is a schematic view of a vehicle including a
control system according to the invention;

Figure 2 is a schematic view of the upper windscreen and
front roof area of the vehicle and control system of

10   Figure 1;

Figure 3 is a block circuit diagram of the UCM 40 in the
rearview mirror housing of Figure 2 for use with a first
embodiment of the RCM 42 in the roof housing of

15   Figure 2;

Figure 4 is a block circuit diagram of the first
embodiment of the RCM 42 in the roof housing of
Figure 2;

20
Figure 5 is a flow diagram illustrating the method by
which the node of Figure 3 controls the reflectivity of
an electro-optic mirror; and

25   Figure 6 is a block circuit diagram of a second
embodiment of the RCM 42 in the roof housing of
Figure 2.

Referring now to the drawings wherein similar numerals
30   have been used to indicate like parts, a vehicle control
system comprises a network of nodes 10 distributed about
the vehicle 11. Each node 10 controls the operation of
particular part of the vehicle, e.g. the engine, brakes,
door locks, etc. In the embodiment of the invention,
35   one of the nodes, identified as UCM 40 in Fig. 1, is

located in the housing of the vehicle interior rear view
mirror as will be described.

Each node 10 in the network communicates with each other
5   node using an industry standard CAN (Controller Area
Network) network protocol. A CAN network is a
multi-master CSMA/CA (carrier sense multiple access
collision avoidance) arbitrated bus, such as has been
developed by Bosch specifically for use in the
10   automotive industry where it is critical that messages
be executed within a pre-determined time span; see, for
example, PCT Application Nos. WO 90/01739 and
WO 94/06081. Each node includes a controller having a
back end and a front end. The back end of the controller
15   is connected to sensors and actuators while the front
end communicates with each of the other node front ends
across a two-wire bus, CAN_H, CAN_L.

The front end of each node controller in a CAN network
20   has a memory containing a table of node-specific message
identifiers. Only messages with these identifiers can
be transmitted or received by the node. There is a
maximum of 2048 identifiers. For transmission, the back
end of the controller writes a message to a message
25   buffer in the front end controller and sets a flag. The
transmission is then automatically executed by the front
end of the controller. The front end decides whether to
process a message placed on the network by any other
node using an acceptance filter. The criterion for this
30   decision is the identifier included in every message.
Only messages, which pass the acceptance filter are
stored in the receive buffer and transferred to the back
end controllers memory.

35   There are a number of available microcontrollers

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incorporating CAN controllers, for example, a Motorola
MC68HC08AZ0. Other examples of CAN controllers are
Philips PCA 82C200 or Intel 82526. These controllers
enable nodes to communicate with one another to transmit
5   the status of sensors or actuators across the network.
It will be seen that because only a two-wire bus is
required to connect each of the nodes on the network
together, significant weight savings can be made in the
vehicle's electrical harness for the same level of
10   functionality.

In the present embodiment, a CAN node 40 for controlling
electronic equipment in the upper area of the vehicle,
referred to as a UCM (upper control module), is located
15   inside the housing 12 of an interior rearview mirror 18,
Figure 2. It is advantageous to place the UCM 40 in the
mirror housing as it is less susceptible to noise and
excess temperatures than if it were located in or
adjacent the roof cavity of the vehicle. It is
20   therefore possible to use a controller and associated
electronics with a lower temperature rating than if the
UCM 40 were placed in the roof cavity. If a higher
rated controller is used, however, it can perform more
reliably than if it were located in the roof cavity.
25

The mirror 18 contains an electro-optic mirror unit,
that is, a mirror unit of a type whose reflectivity can
be varied as a function of an applied voltage. In the
present embodiment the mirror unit comprises an electro-
30   optic cell (EC) 28. As is well known, an electro-optic
cell comprises an electro-optic medium such as an
electrochromic or liquid crystal material sandwiched
between a pair of, usually, glass plates. When a voltage
is applied across the layer it colours, or darkens, to
35   decrease the transmissivity of the cell, the amount of

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darkening increasing with increasing voltage. Within
the mirror housing 12 the cell 28 is located in front of
a reflecting surface (or alternatively the reflecting
surface may be formed directly on one of the glass

5   plates) so that, as seen by the driver, the reflectivity
of the mirror decreases with increasing voltage. The
construction and operation of such mirrors is very well
known in the art; see, for example, U.S. Patent
Nos. 5,140,455, 5,572,354 and 5,151,816, and European

10   Application No. 92308022.0, or as described for example
in the following papers: N.R. Lynam, "Electrochromic
Automotive Day/Mirrors", SAE Technical Paper Series,
870636 (1978); N.R. Lynam, "Smart Windows for
Automobiles", SAE Technical Paper Series, 900419 (1990);

15   N.R. Lynam and A. Agrawal, "Automotive Applications of
Chromogenic Materials", Large Area Chromogenics:
Materials & Devices for Transmittance Control, C.M.
Lampert and C.G. Granquist, eds., Optical Eng'g Press,
Washington (1990).

20

In the present embodiment, electronic equipment in the
upper area of the vehicle is controlled by or
communicates with the UCM 40 and includes the
electro-optic cell (EC) 28 of the mirror 18, a remote

25   keyless entry (RKE) unit 20, a vehicle sun-roof 14, an
alarm siren (not shown), and various lamps, switches and
other equipment contained in a roof housing 16
positioned on the interior roof of the vehicle. The UCM
40 controls, inter alia, the cell 28 and the RKE unit 20

30   directly, but controls the other equipment indirectly
via respective slave controllers which communicate with
the UCM 40 via a local sector network which, in the
present embodiment, is a half-duplex master-slave
network. These other controllers are a roof control

35   module (RCM) 42 located in the roof housing 16, a siren
control module (SCM, not shown) and a sun-roof control

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module (SRCM) 44. In the present embodiment,
master-slave communication is implemented across a
conventional single-wire interface complying with
ISO9141 referred to hereafter as LSB.

Turning now to Figure 3, the UCM 40 of the present
embodiment includes a Motorola MC68H08 microcontroller
22 mounted on a printed circuit board (PCB) within the
mirror housing 12. The controller is connected to the
CAN bus via a CAN interface circuit 23 which includes a
Philips PCA82C250 CAN transceiver. The transceiver
complies with ISO/DIS 11898 and converts the two-wire
CAN bus signal into separate Rx and Tx signal lines
which connect to respective input and output pins on the
controller 22.

The controller 22 is connected to an input circuit 24
and an output circuit 26 for controlling the
transmissivity of the electro-optic cell 28 and hence
the reflectivity of the mirror 18.

The input circuit 24 comprises a series of three
resistors RA, RG and RB which are used to determine the
ambient light levels around the vehicle. Both RA and RG
are light dependent resistors whose resistance is
inversely proportional to the level of light falling on
them. RA and RB are incorporated in respective ambient
light sensors facing forwardly and rearwardly of the
vehicle respectively. Since the construction and
operation of such sensors is well known only the
electrically operative part, the resistors themselves,
are shown in the drawings. The node between RG and RA
is connected via buffer circuitry 32 to an analog input
pin Vglare of the controller. In conditions where the
vehicle is lit primarily from the rear by the headlights
of another vehicle, the level of light falling on RG

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exceeds that falling on RA and the voltage drop across
RG decreases. Vglare thus decreases which, as will be
seen in Fig. 5 to be described, causes the controller 22
to decrease the transmissivity of EC 28 and hence
5   decrease the reflectivity of the mirror 18.

It is desirable to assess the overall ambient light
level in determining the mirror reflectivity so that the
degree of control can be reduced in daylight or
10   relatively bright ambient conditions. RB is a constant
value resistor and the node between RB and RG is
connected via a biasing resistor 34 to an analog input
pin Vec_cutoff of the controller 22. Thus, in
brightening conditions, as the aggregate light level
15   falling on resistors RA and RG increases and their
resistance decreases, the voltage drop across RB also
increases by a corresponding level. It will be seen
that the increasing voltage drop across RB causes
Vec_cutoff to rise gradually, and thus as the overall
20   ambient light level increases the degree of control
gradually decreases as also will be seen in Fig. 5.

The output circuit 26 drives the electro-optic cell 28
via a digital pulse width modulated (PWM) output pin PWM
25   EC to control the mirror reflectivity. In the present
case the output pin PWM EC provides a voltage level of 5
volts when it is on, and zero volts when it is off. PWM
control obviates the need for either an internal or an
externally addressed DAC. It will be seen that by
30   separating the input circuit 24 and the output circuit
26 with the UCM microcontroller, the UCM is able to
assert intelligent software control over the mirror
reflectivity.

35   The cell 28 is connected to the controller 22 via a two
pin connector CN1 on the UCM PCB or alternatively the

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connection may be made with soldered wires. A voltage
difference of 1.4V supplied to the cell 28 across the
two pins of the connector is sufficient to drive the
cell to minimum transmissivity and hence reduce the
5   mirror reflectivity to a minimum, while the absence of a
voltage difference between the two pins clears the cell.
Therefore, a pair of resistors RD1 (100K) and RD2 (39K)
are used to divide the 5 volts on the output pin PWM EC
of the controller in the ratio 28:72, providing 1.4V at
10   the junction of the resistors RD1 and RD2 for a constant
5 volts at PWM EC.

The 5 volt output signal at PWM EC is modulated by the
controller 22 under software control (Fig. 5) to have an
15   on/off duty cycle between 0 and 100%. A capacitor C23,
connected in parallel with resistor RD2, is used to
smooth PWM EC signals with a duty cycle less than 100%
to a substantially constant voltage between 0 and 1.4V
in proportion to the duty cycle. The value of the
20   capacitor C23 is chosen as 1uF so that the corner
frequency of the filter comprising RD1, RD2 and C23 is
significantly below the frequency of the PWM signal to
provide a smooth DC signal. A buffer circuit 57 is
connected between the voltage divided output signal and
25   the connector pin to provide a high impedance quick
clearing output to the cell 28.

Microprocessor control of the cell 28 enables parameters
controlling the level of mirror reflectivity to be
30   programmed. These parameters are:

1.   A threshold ambient light level at which the mirror
should be cleared, (Vec_off);

35   2.   Gain (G); and

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3.   Start of colour (Cs)

These three programmable parameters are stored in
reprogrammable, non-volatile memory and are updated from
5   a computer which plugs into the CAN bus.

Once initiated, a software routine, Fig. 5, runs
continually on the controller 22 and monitors Vec_cutoff
and Vglare to determine the duty cycle of the 5volt
10   signal at the PWM EC output pin. The routine first
checks at step 52 whether the vehicle is in reverse. If
so, the mirror is cleared at step 54 by setting the
desired value of the duty cycle of the PWM EC signal to
0% and updating the duty cycle accordingly at step 66.
15   If not, Vec_cutoff is measured at step 56. The routine
then checks at step 58 if Vec_cutoff is greater than the
pre-programmed threshold level Vec_off. If so, the
mirror is cleared as before at steps 54 and 66.

20   The routine continues by measuring Vglare at step 60 and
the duty cycle of PWM EC is calculated at step 62 using
the formula:

Gain x (Start of colour - Vglare)
25

If this formula produces a negative value, as determined
at step 64, which is possible if Cs is set low, then the
cell is cleared at step 54. Otherwise the duty cycle of
PWM EC is updated at step 66 to the value calculated at
30   step 62, whereupon the routine waits for a
pre-determined delay 68 before returning to step 52.

Returning to Fig. 3, the controller 22 communicates with
each of the RCM, SCM and SRCM slave controllers via the
35   single-wire bus LSB. The half-duplex signalling on LSB
is converted by a conventional ISO 9141 compatible

interface circuit 25 into separate Rx and Tx signal
lines which connect to respective input and output pins
on the controller.

5   The controller 22 communicates with respective
controllers in the slave devices in a frame format
comprising a plurality of words, each word comprising 1
start bit, 9 data bits and 1 stop bit. The controller
22 intermittently transmits a polling frame including a
10   header word, a body comprising up to 8 words and a 1
word checksum onto the bus, LSB. The header word
includes a four bit frame ID, a four bit negated frame
ID, for error checking, with the 9th bit always set to 1.
The nine bit format allows for a parity bit to be used
15   for each word in the body although this is not
necessary. The checksum is a modulo 256-sum of the data
bytes.

If a slave controller sees a frame for which it is to
20   respond, it replies by transmitting a frame including
the relevant data back to the controller 22.

Figure 4 is a schematic illustration of a first
embodiment of the RCM 42 contained in the roof housing
25   16. In the first embodiment, the RCM 42 includes a
Motorola MC68HC05D9 microcontroller 30 mounted on a PCB
in the roof housing 16. The RCM controller 30
communicates with the UCM controller 22 via the bus LSB,
through connectors CN0 and CN3 on the UCM and RCM PCBs
30   respectively. The half-duplex signalling on LSB is
converted by an interface circuit 31 circuit
corresponding to the interface circuit 25 of the UCM 40
which converts the LSB signal into separate Rx and Tx
signal lines which connect to respective input and
35   output pins on the controller 30.

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The RCM controller 30 is connected to three switches FL,
Gen and FR mounted on the RCM PCB in the roof housing
16. Each switch includes switch contacts located behind
respective buttons exposed at the surface of the roof
5   housing 16 which are actuable from within the vehicle
cabin to open and close the switch contacts. Each
switch has an associated LED L1, L2, L3 which are wired
in series and connected between a protected battery
voltage 12V nominal and via a current limiting resistor
10   RL to the collector of a transistor Q1. The base of Q1
is connected to a digital output pin LED O/P via a
resistor-divider network RD5, RD6. In low ambient light
conditions, as determined by the controller 30 over the
CAN network, LED O/P is switched high to turn on the
15   transistor Q1 and light the LED's which in turn
illuminate the buttons of their respective switches FL,
Gen, FR.

The RCM controller 30 is further connected to a sun-roof
20   switch 32 also mounted within the roof housing 16,
Figure 2, the switch 32 also having an LED for inbuilt
illumination of the switch. A suitable switch is
manufactured by Alps Electric Co. Ltd. Japan. The
switch 32 is connected to the controller 30 via a
25   multi-wire flexible cable to a connector CN2 on the RCM
PCB. The collector of the transistor Q1 is connected
via a driver circuit 33 to a pin, Light, on the
connector CN2 so that when LED O/P is switched high, the
sun-roof switch is also illuminated.
30
The sun-roof switch includes outputs indicating the
direction a user wishes to move the sun-roof 14 -
forward (FWD), backward(BWD), tilt (Tilt) and automatic
open (Auto). Each output is connected to a respective
35   input pin on the controller 30 via the connector CN2.
When any output changes state, the controller 30 waits

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to be polled by the UCM controller 22 before
transmitting the information relating to the change of
state of the switch 32.

5   The UCM controller 22 then polls the controller (not
shown) in the SRCM 44 via LSB to communicate the
position of the sun-roof switch to the SRCM. The
sun-roof controller then moves the sun-roof, or not, in
the appropriate direction. It will be seen that because
10   the sun-roof switch 32 is not connected directly to the
sun-roof 14, but via the UCM 40, the conditions under
which the roof opens/closes or tilts can be user
specified.

15   The technique whereby the RCM controller 30 communicates
a change in state of an input to the UCM controller 22
which in turn instructs a slave node, for example the
RCM 42 itself, to actuate an output, is also applied to
the switching of lamps located around the vehicle.

20
A number of such lamps are mounted on the RCM PCB in the
roof housing 16, that is, two general lamps GEN1, GEN2
and left and right front reading lamps FLL and FRL,
Figs. 2 and 4. Each lamp is switched by an output pin of
25   the controller 30 via one channel of a quad high side
driver SW1 to the battery voltage Vbb. The RCM
controller 30 is further connected to vanity lamps (not
shown) located above two front sun-visors and two rear
side rail reading lamps (not shown) through a second
30   quad high side driver SW2. These lamps and the
respective switches (not shown) for the side rail
reading lamps are connected to the RCM PCB via the
connector CN3.

35   The RCM 42 uses PWM control to ramp the voltage supply

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when turning on the general lamps GEN1 and GEN2, and to
control the final voltage supplied to the general lamps
as well as the voltage supplied to the vanity lamp and
to the front reading lamps FLL, FRL to prevent
overdriving the lamps due to variations in the battery
level Vbb.

The general lamps GEN1, GEN2 are both ramped on when a
vehicle door is opened, or when the Gen switch is
closed, in the following manner. In the former case the
opening of a door is signalled across the CAN bus to the
UCM controller 22 in known manner, while in the latter
case the controller 30 reports the closure of the Gen
switch to the UCM controller 22. In either case the
controller 22 then instructs the RCM controller 30
across the bus LSB to turn on the general lamps GEN1,
GEN2 by specifying a maximum PWM duty cycle of a 5v PWM
output pin, General. This specified maximum PWM duty
cycle is inversely proportional to the battery voltage
Vbb,   which is determined by the UCM controller 22 via
a resistor-divider network RD3, RD4, Figure 3.

The General output pin is connected to two inputs on the
quad high side driver SW1. When enabled by a 5v signal
from the General output pin, these inputs connect the
battery voltage Vbb to the respective general lamps
GEN1, GEN2; thus the battery voltage supplied to the
lamps GEN1, GEN2 is pulse width modulated with the same
instantaneous duty cycle as the voltage at the General
output pin.

The RCM controller 30 steps the General output from 0%
to the maximum PWM duty cycle specified by the UCM
controller 22 over a pre-determined number of steps as a
function of time. By matching the step increments to

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the increasing resistance value of the lamp filaments as
they heat up, the power dissipated by the lamps is
ramped approximately linearly and so the problem of lamp
failure due to thermal shock is mitigated as well as
5   providing an enhanced visual effect.

Similarly, the RCM controller 30 is instructed to turn
on the front reading lamps FLL, FRL and the vanity lamp
located in the sun visor by the UCM controller 22. In
10   the case of the front reading lamps, the RCM controller
30 detects the closing of switch FL or FR and reports
this to the UCM controller 22. The UCM controller 22
then instructs the RCM controller 30 to turn on the
respective lamp FLL or FRL by enabling output F1 or F2
15   and specifying a constant PWM duty cycle of the voltage
at an output, PWM Const, of the controller 30. As
before, the specified PWM duty cycle is inversely
proportional to battery level.

20   In the case of the vanity lamp, the RCM controller 30 is
instructed to switch the vanity lamp on by the UCM
controller 22 when the latter sees across the CAN bus
that the sun-visor has been pulled down. This is done
by enabling the Vanity output of the controller 30 and
25   again specifying a constant PWM duty cycle of the
voltage at the output PWM Const inversely proportional
to battery level.

Each of the outputs F1, F2 and Vanity is "anded" with
30   the output PWM Const so that only that lamp whose output
from the controller 30 is enabled will illuminate. It
will be observed that in contrast to the general lamps,
the reading and vanity lamps are not ramped up but are
switched on immediately to the specified constant PWM
35   duty cycle. This reduces the amount of software control

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that would have been required to produce three
independent PWM signals.

It will be recognised that the conditions under which
the any of the lamps connected to the RCM 42 are
switched on and off can be customised by programming the
UCM controller 22. For example, the controller 22 could
be programmed to ignore the opening of a door or the
switching on of one of the switches FL, Gen or FR if it
determined that the ambient light level were
sufficiently high not to warrant turning on the
corresponding lamp. The voltage at the junctions of the
resistors RA, RG, RB which control the electro-optic
cell 28 could be used for determining ambient light
level for this purpose, or as in the present embodiment
the ambient light level can be determined by the UCM
controller 22 across the CAN bus from a separate light
sensor.

The RCM 42 is also connected to a climate control unit
53 comprising a fan and a thermistor (not shown). Power
is supplied to the fan from the RCM 42. A Fan output of
the controller 30 is connected to an input of the driver
SW2. The corresponding output of the driver SW2 is
connected to a pin FAN on a connector CN4. The
thermistor has two terminals connected directly to
respective pins THS, TLS on the connector CN4. These
pins are connected to respective pins on the connector
CN3 which are in turn connected via the vehicle harness
to respective pins on the UCM connector CN0. The
differential signal is passed through conditioning
circuitry 27 and connected to an analog input Temp of
the UCM controller 22. The temperature of the vehicle
cabin can thus be relayed by the UCM controller to any
other nodes across the network.

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For example, if the temperature of the cabin rose to
dangerous levels while the vehicle were stationary and,
if the presence of a person in the vehicle were detected
by a seat occupancy detector (see below), the sun-roof
5   could be instructed to open slightly by the SRCM.
Similarly, if a rain sensor (see below) indicates rain,
the SRCM may not open the sun-roof.

The UCM controller 22 also controls the remote keyless
10   entry RKE unit 20 which is also mounted within the
mirror housing 12. The UCM 40 is connected to the RKE
unit 20 via a multi pin connector CN5. Among other
signals, 5V power is supplied to the RKE unit 20 from
the RKE Power output pin on the controller 22 via one
15   connector pin and data is returned by the RKE unit 20 to
the RKE Data input pin on the controller 22 via the
second connector pin.

It will be seen that it is not desirable for all of the
20   vehicle electronics to be drawing battery power while
the vehicle is stationary without its engine running for
more than a pre-determined time. The CAN nodes of the
network therefore enters a low power sleep mode.

25   In the present embodiment, a wake up timer has a
frequency approximately 3Hz and is connected to an input
pin of the UCM controller 22. When interrupted, the
controller 22 interrogates the RKE unit 20 to determine
if the vehicle is to be entered legitimately. During at
30   least one of these interrupts, the controller 22 also
sends a message to the SCM via LSB to tell the siren
that the network is functioning normally and that an
alarm is not to sound.

35   Battery power to the slave nodes RCM 42 and SRCM 44 as
well as a mass motion sensor unit (MMS) is switched by

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the UCM 40. An RCM power output pin (RCM Power O/P) is
connected to an input channel of a quad high side driver
SW0 on the UCM PCB. A signal on this pin connects the
battery voltage Vbb to a line RES which connects to the

5   connector CN3 on the RCM PCB via the connector CN0 on
the UCM PCB. The RES signal is in turn channelled by
the connector CN3 to the SRCM 44 on line SSS. Thus, when
in sleep mode the UCM 40 can remove power from the RCM
and SRCM slave nodes in the master-slave network.

10
An Alarm output of the UCM controller is independently
connected to an input of the driver SW0. A
corresponding output pin of the driver is connected to a
pin (Alarm Power) on the connector CN0 which is

15   connected via the vehicle harness to the MMS. Thus, the
UCM 40 can remove power from the MMS when the vehicle
has been legitimately entered, so that the ADA signal is
not asserted.

20   The MMS supplies a sensor output signal ADA to the UCM
controller 22 via a mass motion sensor interface (MMS
I/F). The UCM controller 22 is therefore able to
determine whether an alarm should sound. It should be
understood that the ADA signal will be active as soon as

25   someone enters the vehicle illegally.

The mirror housing 12 also includes seat belt warning
lamps 15, Fig. 3. These lamps are connected in series
to the collector of a transistor Q2 whose base is

30   connected to an output pin of the controller 22. In the
present embodiment, when the vehicle ignition is turned
on, the UCM controller 22 flashes the seat belt warning
lamps 15 for a pre-determined time or until the UCM is
instructed over the CAN bus to stop. The lamps are

35   displayed prominently on the mirror housing 12 where

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they are sure to be noticed by any occupants of the
vehicle.

In a typical CAN network, vehicle parameter values are

5   usually calculated at one node. If another node wishes
to determine the value of the parameter, it monitors the
value across the network. It will be seen, however,
that due to the limitation in the number of message
identifiers and bandwidth of the network, there is a

10   cost in software in communicating sensor/actuator values
across the network. For this reason, it is advantageous
to hardwire certain signals within the vehicle control
system.

15   In a second embodiment of the RCM 42, Figure 6, the
microcontroller 30 is removed, and the roof housing
electronics including the lights and switches are
controlled directly by the UCM controller 22 across the
vehicle harness via hard wire connections. The required

20   changes are described with reference to the RCM 42 only,
with changes being made mutatis mutandi to the UCM 40.

For ease of mounting within the roof housing 16, the RCM
42 comprises two separate PCB's, PCB A and PCB B, linked

25   together via a multi-wire cable. In the second
embodiment, the three switches FL, Gen and FR of the
first embodiment are mounted on PCB A, and their
respective outputs are encoded into a two wire output by
encoding circuitry 61. The two wire output is connected

30   via a connector CN6 across the multi-wire cable to a
connector CN7 on PCB B. The two wires are then further
connected via another connector CN8 to the vehicle
harness which in turn connects the two wire output to
the UCM 40. The two wire output is decoded either by

35   dedicated decoding circuitry or within the UCM
controller 22 to determine the status of the switches.

A light output corresponding to the LED O/P from the
controller 30 of the first embodiment is directly
connected between the UCM controller 22 and the switches
FL, Gen and FR in the second embodiment. The light
5   output is connected via the connectors CN8, CN6 and CN7
and the three wire cable to power the switches as
before.

In both the first and second embodiments, placing of the
10   sun-roof switch 32 is optional. In the second
embodiment, the switch 32 is connected to the PCB B via
multi-wire cable and a connector CN2' corresponding to
CN2 of the first embodiment. When placed, the four
switch outputs FWD, BWD, Tilt and Auto are further
15   connected to the sun-roof control module SRCM 44 via a
connector CN9. This obviates the need for the UCM 40 to
communicate the status of the switch 32 to the SRCM 44
as in the first embodiment. In order to illuminate the
switch 32, the light output is connected via the
20   connector CN2' to the switch 32 so that, when placed,
the sun-roof switch 32 is illuminated with the buttons
FL, Gen and FR.

Because the FWD signal from the switch 32 is critical,
25   it is split on the PCB B, and a duplicate signal FWD 2,
is connected via the connector CN8 and a separate
portion of the vehicle harness to the SRCM 44.

Placing of the fan unit 53 is also optional. In the
30   second embodiment, the unit 53 is connected to the PCB B
via a connector CN4' corresponding to CN4 of the first
embodiment. The three signals FAN, TLS and THS are
connected to the UCM 40 as before.

35   In the second embodiment, the four lamps GEN1, GEN2, FLL

and FRL are controlled directly by the UCM 40. Three
pulse width modulated control signals, corresponding to
General and the outputs of the gates A1 and A2 of
Figure 4 are generated by the UCM 40 rather than within
5   the RCM, and are connected via the vehicle harness to
the connector CN8 from which they are connected to the
lamps.

It will be appreciated by those skilled in the art that
10   the invention can be used to control a prismatic mirror
rather than an electro-optic mirror as described.
Prismatic mirrors are well known in the art and include
a prism which can be moved between first and second
angular positions providing different degrees of
15   reflectivity as seen by the driver. In the context of
the present invention such a prism can be motor driven
between its first and second positions, to achieve a
variable reflectivity mirror, with control of the motor
being effected by the UCM controller 22 in accordance
20   with the signals from the ambient light sense resistors
RA, RG and RB. Since prismatic mirrors normally have
only two states, PWM would not be necessary in that case
and the output from the controller 22 could be a single
signal which was either on or off according to the
25   desired angular position of the prism. Alternatively, a
prismatic mirror can be manually actuated between two
angular positions to give a variable reflectance mirror.

Also, while the invention has been described herein in
30   terms of a CAN network, the invention could
alternatively be implemented in any other suitable
network, for example a network conforming to the French
standard VAN (Vehicle Area Network) or the US standard
J1850, or a purpose designed proprietary network could
35   be used.

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It will be further appreciated by those skilled in the art that various other vehicle components and systems may be associated with the vehicle control system and/or rearview mirror as described herein. For example, a
5   battery level indicator, various lighting systems, vehicle tyre indicators, blind spot warning data, GPS antenna and directional information, intelligent vehicle highway system information, safety warning system information, rain sensor information provided by
10   windshield contacting or non-contacting sensors, compass information for example from flux gate, magneto inductive or magneto resistive compasses, temperature information, trainable or universal garage door opening systems, vehicle seat positioning and occupancy
15   detection systems, intrusion detection systems, cellular telephone and pager systems, emergency rescue systems, sun-roof (which could be electro-optic) control system and memory storage of various functions and data applicable to the above in addition to any other
20   desirable vehicular information.

It will also be seen that the vehicle control system can be used to control one or more outside electro-optic, for example, electrochromic mirrors (not shown). This
25   can be achieved by hardwiring the UCM 40 to the or each outside mirror, similar to the way in which the vanity lights are connected to the RCM 42; or by connecting the UCM via the bus LSB to one or more slave outside mirror controllers (not shown) which control the or each
30   outside mirror; or by connecting the UCM via the CAN bus to a another CAN node for controlling the or each outside mirror.

The invention is not limited to the embodiments
35   described herein which may be modified or varied without departing from the scope of the invention.

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CLAIMS

1.   A vehicle rearview mirror comprising a mirror
housing containing a variable reflectivity mirror unit
and a microcontroller for controlling the reflectivity
of the mirror unit.

2.   A vehicle rearview mirror according to claim 1,
further including connection means adapted to connect
the microcontroller to a vehicle control network, the
microcontroller forming a node of said network.

3.   A vehicle rearview mirror according to claim 2,
wherein the mirror housing further includes at least one
seat belt warning lamp for indicating that seat belts
should be fastened.

4.   A vehicle rearview mirror according to claim 2,
wherein the mirror housing further includes a remote
keyless entry device.

5.   A vehicle rearview mirror according to claim 2,
wherein the vehicle control network is a CAN network and
the node is a CAN node.

6.   A vehicle rearview mirror according to claim 2,
wherein the connection means is further adapted to
connect the microcontroller in the mirror housing to a
further microcontroller located exterior to the mirror
housing, the microcontroller in the mirror housing and
the further microcontroller being in master/slave
relationship.

7.   A vehicle rearview mirror according to claim 6,
wherein the master microcontroller communicates with the

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slave microcontroller according to an ISO 9141
communication protocol.

8. A vehicle rearview mirror according to claim 1,
wherein the reflectivity of the mirror unit is varied
under software control according to a selected value of
at least one parameter.

9. A vehicle rearview mirror according to claim 1,
wherein the microcontroller controls the reflectivity of
the mirror unit according to the state of at least one
ambient light sensor.

10. A vehicle rearview mirror according to claim 9,
wherein the mirror unit includes an electro-optic cell
whose transmissivity is determined in accordance with
the duty cycle of a pulse width modulated signal
provided by the microcontroller.

11. A vehicle rearview mirror according to claim 10,
wherein said pulse width modulated signal is smoothed to
provide a substantially constant voltage signal which is
applied to the cell.

12. A vehicle control system comprising a rearview
mirror housing, a variable reflectivity mirror unit
mounted in the mirror housing, a first microcontroller
mounted in the mirror housing for controlling the
reflectivity of the mirror unit, a second
microcontroller mounted in the vehicle outside the
mirror housing and connected to the first
microcontroller, and at least one input and/or output
device connected to the second microcontroller.

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13. A vehicle control system according to claim 12,
wherein the first microcontroller is a master
microcontroller and the second microcontroller is a
slave microcontroller.

14. A vehicle control system as claimed in claim 12,
further including a roof housing positioned on the
interior roof of the vehicle, the second microcontroller
being mounted in the roof housing.

15. A vehicle control system according to claim 12,
wherein the first microcontroller controls the
reflectivity of the mirror according to the state of at
least one ambient light sensor.

16. A vehicle control system according to claim 15,
wherein the mirror unit includes an electro-optic cell
whose transmissivity is determined in accordance with
the duty cycle of a pulse width modulated signal
provided by the first microcontroller.

17. A vehicle control system according to claim 16,
wherein said pulse width modulated signal is smoothed to
provide a substantially constant voltage signal which is
applied to the cell.

18. A vehicle control system according to claim 14,
wherein the roof housing contains at least one vehicle
interior lamp and the second microcontroller controls
the operation of the lamp.

19. A vehicle control system according to claim 18,
wherein the vehicle interior lamp is turned on by the
second microcontroller upon opening of a vehicle door,

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and wherein the power dissipated by the lamp upon said
turning on is gradually increased from zero to a maximum
which is a function of the vehicle battery voltage.

5   20.   A vehicle control system according to claim 19,
wherein the power dissipated the lamp is determined in
accordance with the duty cycle of a pulse width
modulated signal provided by the second microcontroller.

10   21.   A vehicle control system according to claim 13,
wherein the master microcontroller is a node on a
vehicle control network.

22. A vehicle control system according to claim 21,
15   wherein the master microcontroller communicates with the
slave microcontroller according to an ISO 9141
communication protocol.

23. A vehicle control system according to claim 13,
20   wherein at least two slave microcontrollers are
connected to the master controller, and wherein the
master microcontroller controls an output device
connected to one of said slave microcontrollers in
response to an input device connected to the other of
25   said slave microcontrollers.

24.   A vehicle control system comprising a network
controlling a plurality of functions of the vehicle, the
network having a node located in a rearview mirror
30   housing of the vehicle, such node controlling at least
one function of the mirror.

25. A vehicle control system according to claim 24,
wherein said node also forms part of a local sector
35   network including at least one further node in addition

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to said node, said node and said further node being
connected in master/slave relationship.

5   26.   A vehicle control system according to claim 24 or
25, further including a roof housing positioned on the
interior roof of the vehicle, said housing including at
least one input and/or output device, the or each device
being controlled directly by the node.

10   27.   Apparatus for determining an optical characteristic
of a vehicle component in accordance with the duty cycle
of a pulse width modulated signal.

28.   Apparatus according to claim 27, wherein the
15   component is a rearview mirror unit and the
characteristic is its reflectivity.

29.   Apparatus according to claim 27, wherein the
component is an interior lamp and the characteristic is
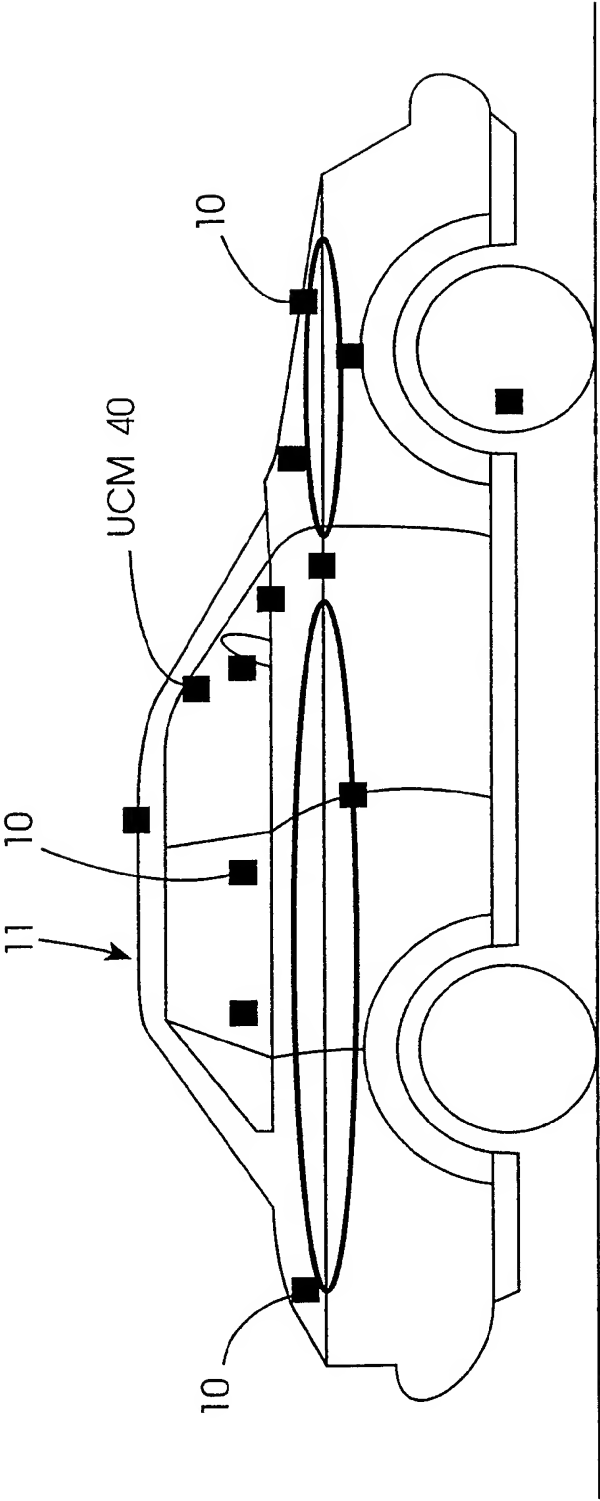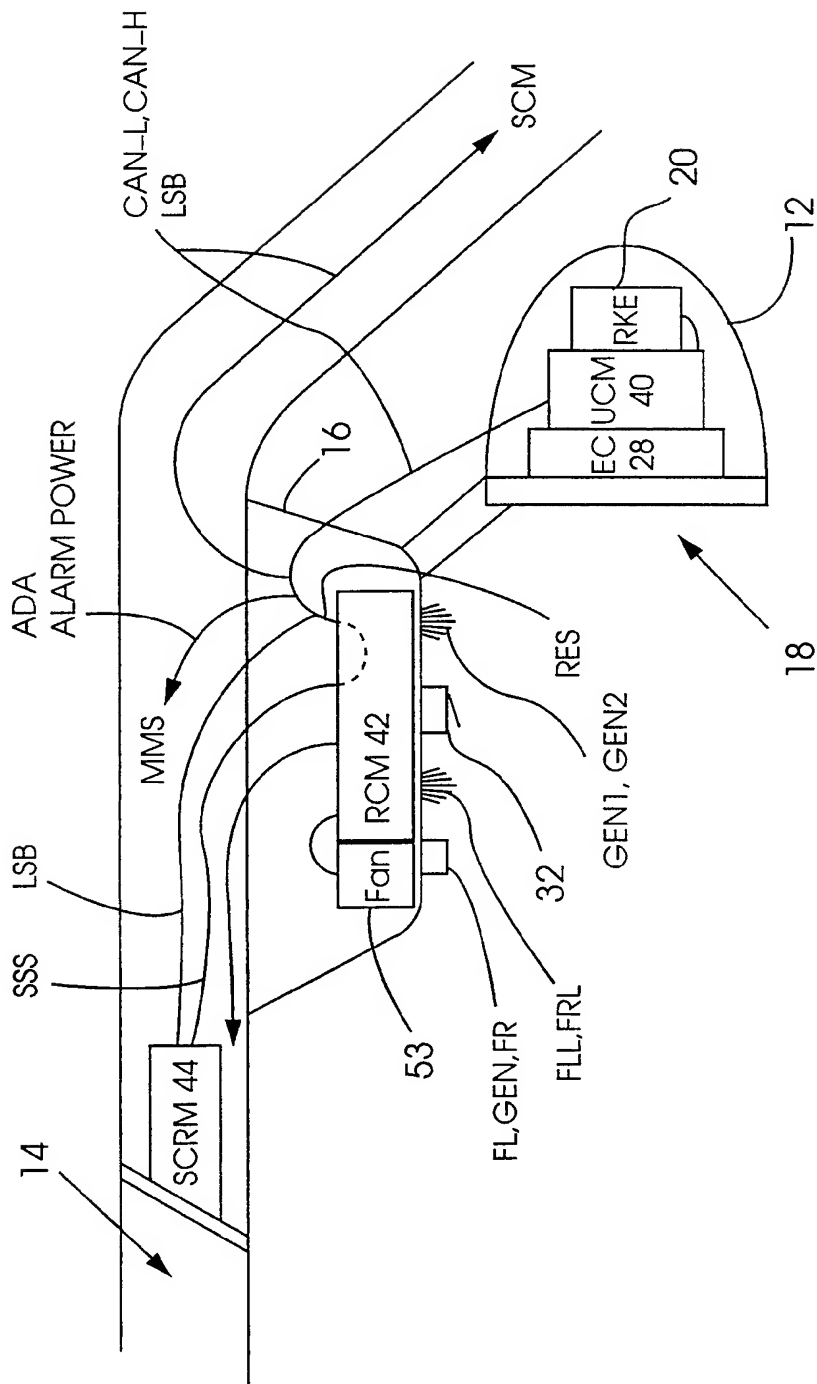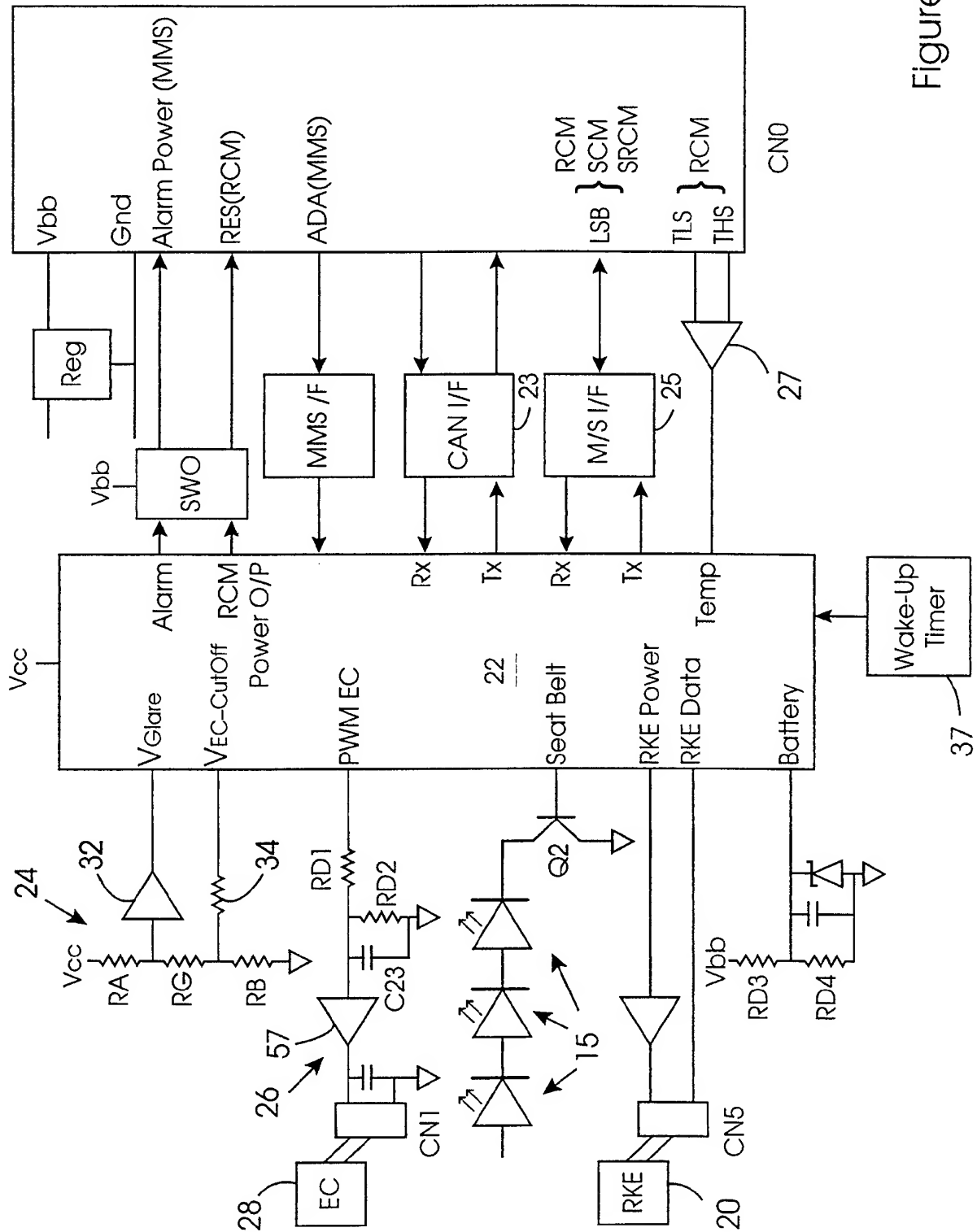its brightness.
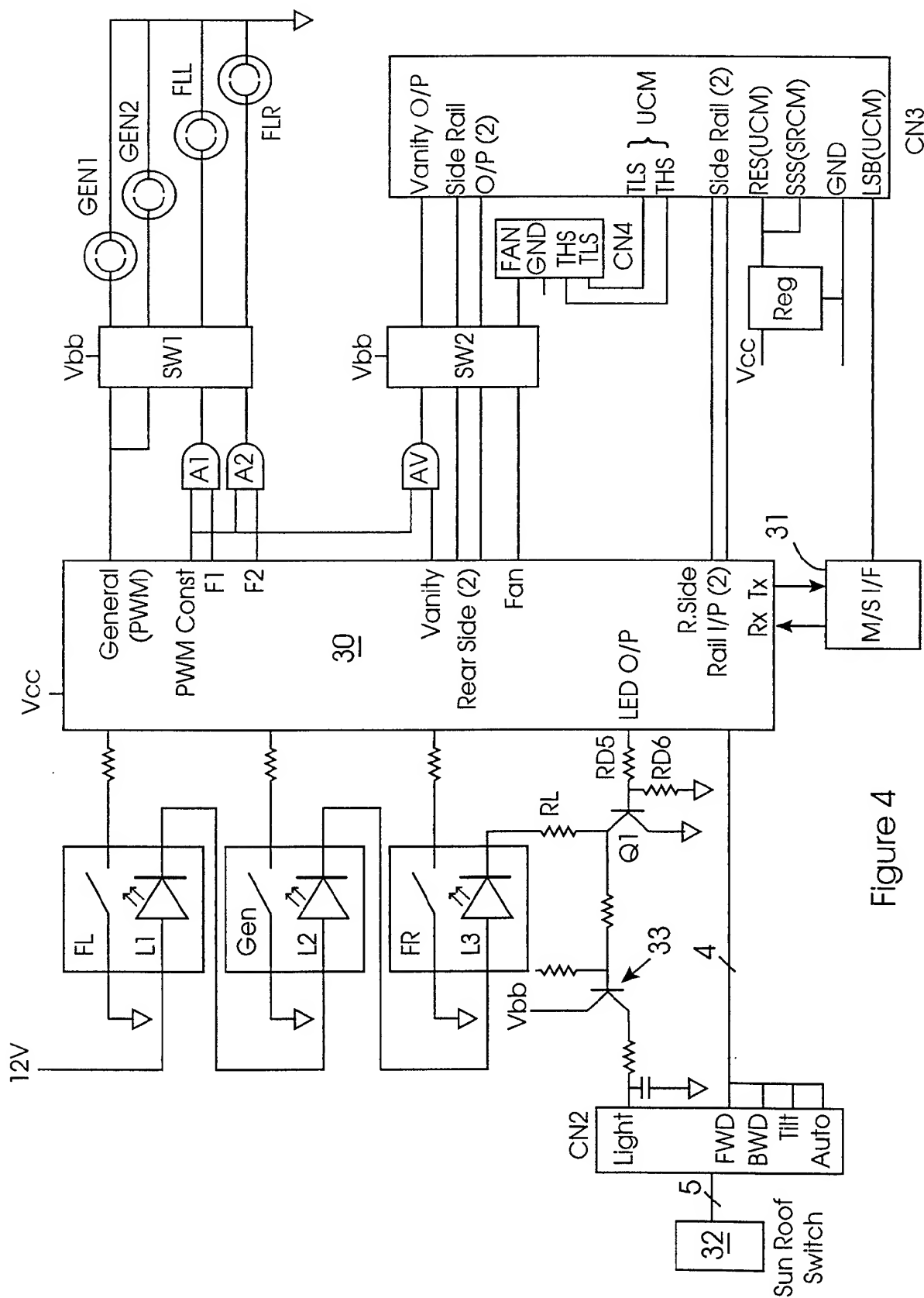
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Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

PCB B

CN4'   Fan

UCM —3—
                                    Fan
                                    TLS,THS
                                                                    2   53

                                                                        Sun-Roof
                                                                        Switch
SRCM —4—
                                                                    4   32

CN9

SRCM ————   FWB2
                        LSB (n/c)
UCM —9—   RES   Light
                        GND

                        3   GEN1
                                           GEN2
PCB A
                        CN8   FLL
         FR
                    CN6   CN7   FLR
         GEN   ENC   2

                    61   Power
         FL   Gnd

         Light
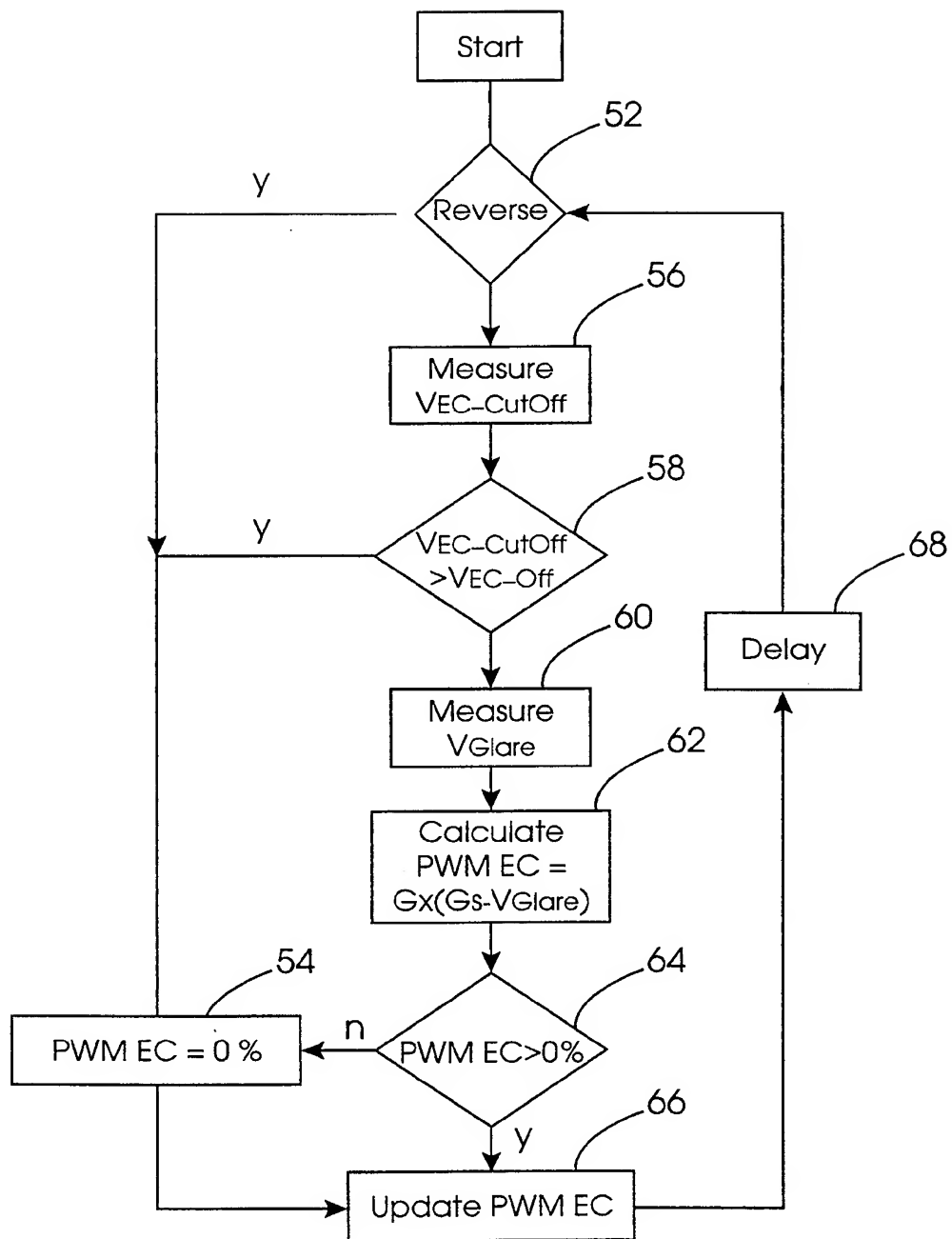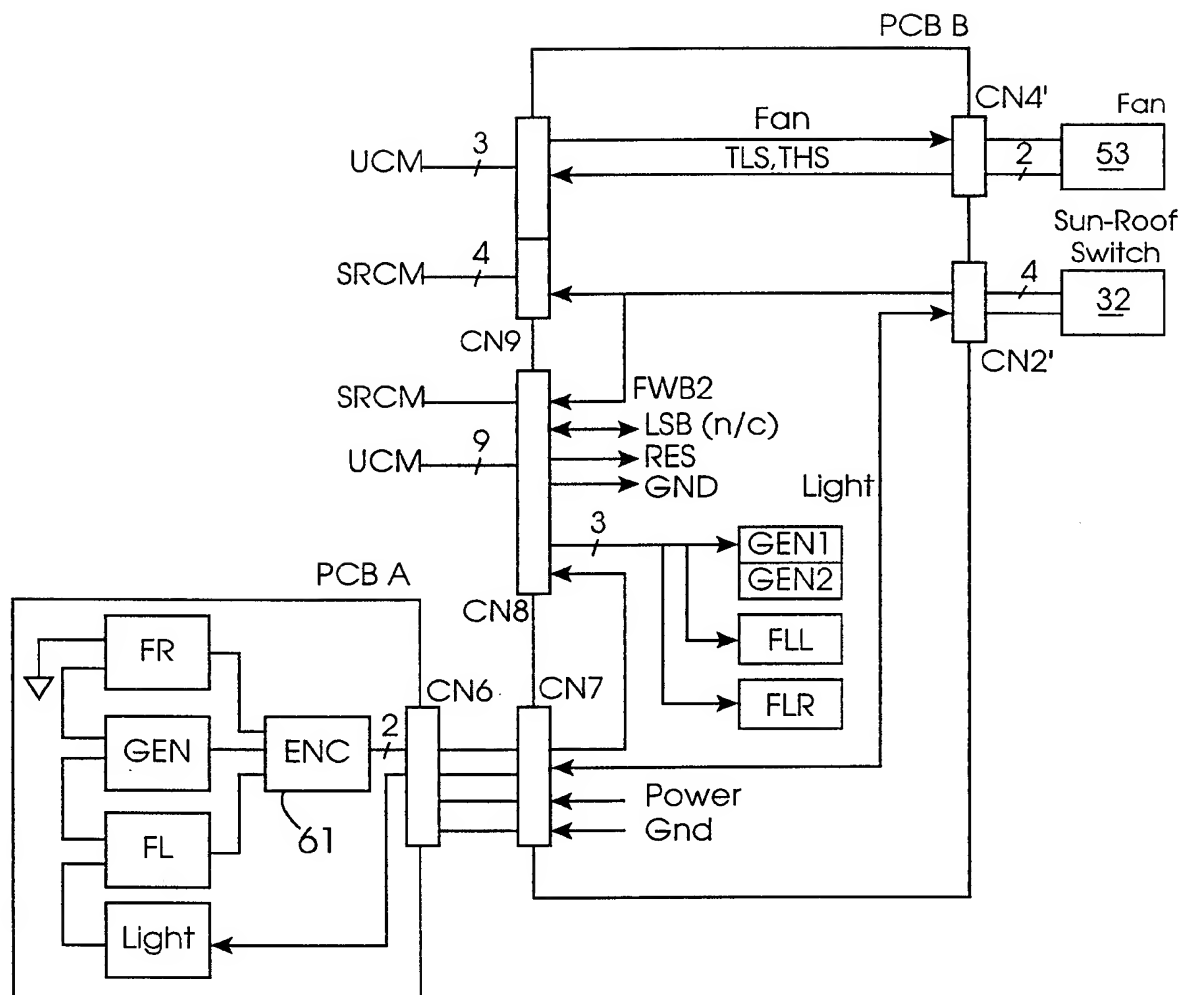
Figure 6

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   B60R1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 451 822 A (BECHTEL JON H ET AL) 19 September 1995	1,8,9
Y	see column 2, line 40 – column 3, line 59	2,5-7, 10-15, 21-26
	see column 7, line 64 – column 11, line 9 see column 13, line 48 – column 17, line 9; figures 1-6T	
Y	DE 43 40 048 A (BOSCH GMBH ROBERT) 1 June 1995	2,5-7, 10-15, 21-26
	see column 1, line 52 – column 8, line 12; figures 1-4	
	-/--	

| X | Further documents are listed in the continuation of box C. | | X | Patent family members are listed in annex. |

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 April 1998	16/04/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Geyer, J-L

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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Y	see the whole document	10,11
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